PATENT COOPERATION TREATY

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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference PCTP170931	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/NL 03/00750	International filing date *(day/month/year)* 31.10.2003	Priority date *(day/month/year)* 31.10.2002
International Patent Classification (IPC) or both national classification and IPC G01N21/64		
Applicant PLANT RESEARCH INTERNATIONAL B.V. ET AL.		

CORRECTED VERSION

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 6 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 4 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the opinion
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   - VI ☐ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
27.05.2004	25.01.2005
Name and mailing address of the international preliminary examining authority: European Patent Office - P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk - Pays Bas Tel. +31 70 340 - 2040 Tx: 31 651 epo nl Fax: +31 70 340 - 3016	Authorized Officer Verdoodt, E Telephone No. +31 70 340-3577

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/NL 03/00750

I. Basis of the report

1. With regard to the **elements** of the international application *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*:

Description, Pages

1-12 as originally filed

Claims, Numbers

1-8, 11-13, 15-17 received on 18.08.2004 with letter of 18.08.2004

9, 10, 14, 18 received on 26.11.2004 with letter of 26.11.2004

Drawings, Sheets

1/1 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:
- ☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)).

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-18
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-18
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-18
	No:	Claims	

2. Citations and explanations

see separate sheet

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1.1 Reference is made to the following documents:

D1: B.GENTY, S.MEYER: "Quantitative mapping of leaf photosynthesis using chlorophyll fluorescence imaging" AUSTRALIAN JOURNAL OF PLANT PHYSIOLOGY, 1994, pages 277-284, XP008018804

D2: WO 01/00333 A (CALCOEN JOHAN ;CUYPERS JAN (BE); DEBAES NATHALIE (BE); JANSSENS CA) 4 January 2001 (2001-01-04)

2.1 The document D1 is regarded as being the closest prior art to the subject-matter of **claim 1**, and shows (the references in parentheses applying to this document):

2.2 A method for determining the quality of plant material by determining a chlorophyll fluorescence image of said plant material, wherein the plant material is irradiated with a beam of electromagnetic radiation comprising one or more such wavelengths that at least a part of the chlorophyll present is excitated by at least a part of the radiation, wherein the fluorescence radiation originating from the plant material associated with the chlorophyll transition, is measured with an imaging detector for obtaining a chlorophyll fluorescence image.

2.3 The subject-matter of claim 1 differs from this known D1 in that

- the beam of electromagnetic radiation having such a shape that only a small part of the plant material is irradiated and
- during a certain duration of time several fast scans are made over the plant material with the electromagnetic beam for obtaining a chlorophyll fluorescence image Ffast, and during a certain duration of time a slow scan is made over the plant material with the electromagnetic beam for obtaining a chlorophyll fluorescence image Fslow, and subsequently the characteristic chlorophyll fluorescence image that is a measure for the efficiency of the photosynthetic system of plant material is calculated from the chlorophyll fluorescence images Ffast and Fslow.

The subject-matter of **claim 1 is therefore new** (Article 33(2) PCT).

2.4 The problem to be solved by the present invention may be regarded as how to determine the efficiency of the photosynthetic system of a piece of plant material which is too large to be irradiated with a saturating light pulse.

2.5 The solution to this problem proposed in **claim 1** of the present application is considered as involving an **inventive step** (Article 33(3) PCT) for the following reasons:
- Although D1 does not show the use of a beam of electromagnetic radiation having a small diameter, nor the use of a scanner, the skilled person would think of a scanning laser beam as in D2, to irradiate an area, which is too large to illuminate with a single flash of light.
- However, the skilled person would not find in D2, nor in D1, the idea of using two scans at different speeds, in order to obtain two different images, from which to calculate a characteristic chlorophyll fluorescence image, that is a measure for the efficiency of the photosynthetic system of plant material.

2.6 Claims 2-8 are dependent on claim 1 and as such also meet the requirements of the PCT with respect to novelty and inventive step.

3.1 The document D2 is regarded as being the closest prior art to the subject-matter of **claim 9**, and shows (the references in parentheses applying to this document):

3.2 A device *suitable* for determining the quality of plant material (page 5, lines 32-5) by determining a chlorophyll fluorescence image of said plant material, comprising
- first means (9) for irradiating the plant material (1) with a beam of electromagnetic radiation comprising one or more such wavelengths that at least a part of the chlorophyll present in the plant material is excitated (page 11, lines 26-28),
-first means for scanning the beam of electromagnetic radiation over the plant material with a high scan frequency (page 10, lines 15-21),
- first means for measuring the fluorescence radiation (12; page 7-line 22: "camera") originating from the plant material for obtaining a chlorophyll fluorescence image (Ffast) (Page 12, lines 11-15) associated with the fast scan,
-second means (9) for irradiating the plant material (1) with a beam of electromagnetic radiation comprising one or more such wavelengths that at least a part of the chlorophyll present in the plant material is excitated (page 11, lines 26-28),
- second means for scanning the beam of electromagnetic radiation over the plant material with a low scan frequency (page 10, lines 15-21),
- second means for measuring the fluorescence radiation (12; page 7-line 22: "camera") originating from the plant material for obtaining a chlorophyll fluorescence image (Fslow) (Page 12, lines 11-15) associated with the slow scan and means for processing (13) the chlorophyll fluorescence images Ffast and Fslow.

3.3 The subject-matter of claim 9 differs from this known D2 in that the processing means is provided with calculating means ***adapted*** for calculating a characteristic chlorophyll fluorescence image that is a measure for the quantum efficiency of the photosynthetic activity of the photosynthetic system of the plant material, according to the method of claims 1-8.
As this method is considered to be novel and inventive, as argued in paragraph 2.1-2.6 above, and the computer of D2 clearly is not equipped with software adapted for the required calculations, claim 9 is also considered new and inventive (Articles 33(2) and 33(3) PCT).

4.1 **Claims 10, 14 and 18** are dependent on claim 9, and as such also meet the requirements of the PCT with respect to novelty and inventive step.

5.1 Method **claims 11 and 15** can be independent or dependent claims, due to the fact that they can depend on either method claims 1-8 or device claims 9 or 10.
5.2 In case method claims 11 and 15 refer to method claims 1-8 they are dependent and as such also meet the requirements of the PCT with respect to novelty and inventive step.
5.3 In case these method claims 11 and 15 depend on the device claims 9 or 10, they are independent due to the switch of category. In this case the subject-matter of independent claims 11 and 15 is also new and inventive in the sense of Articles 33(2) and 33(3) PCT, as the used device of claim 9 is also new and inventive.

6.1 **Claims 12 and 13, and claims 16 and 17** are dependent on claims 11 or 15 respectively, and as such also meet the requirements of the PCT with respect to novelty and inventive step.

CLAIMS

1. A method for determining the quality of plant material by determining a chlorophyll fluorescence image of said plant material, wherein the plant material is irradiated with a beam of electromagnetic radiation comprising one or more such wavelengths that at least a part of the chlorophyll present is excitated by at least a part of the radiation, the beam of electromagnetic radiation having such a shape that only a small part of the plant material is irradiated, and the beam being moved over the plant material such that a larger part of the plant material is irradiated, wherein the fluorescence radiation originating from the plant material associated with the chlorophyll transition, is measured with an imaging detector for obtaining a chlorophyll fluorescence image, wherein, in any given order,

during a certain duration of time several fast scans are made over the plant material with the electromagnetic beam for obtaining a chlorophyll fluorescence image Ffast, and

during a certain duration of time a slow scan is made over the plant material with the electromagnetic beam for obtaining a chlorophyll fluorescence image Fslow, and subsequently

the characteristic chlorophyll fluorescence image that is a measure for the efficiency of the photosynthetic system of plant material is calculated from the chlorophyll fluorescence images Ffast and Fslow.

2. A method according to claim 1, the characteristic chlorophyll fluorescence image containing information about the quantum efficiency of the photosynthetic activity of the photosynthetic system of the plant material and this image being calculated with the formula

$$IQP=(Fslow-Ffast)/Fslow$$

3. A method according to any one of the preceding claims, the beam having the shape of a thin line.

4. A method according to any one of the preceding claims, the beam being moved such over the plant material that the entire surface of the plant material is irradiated.

5. A method according to any one of the preceding claims, the electromagnetic radiation used for irradiating the plant material having a wavelength of between 200 and 750 nm.

6. A method according to any one of the preceding claims, the electromagnetic radiation used for irradiating the plant material being generated by a lamp, laser of LED-lamp.

7. A method according to any one of the preceding claims, the fluorescence radiation originating from the plant material being measured between 600 and 800 nm.

8. A method according to any one of the preceding claims, the fluorescence radiation originating from the plant material being measured with an electronic camera consisting of a video camera, CCD-camera, line scan camera or a number of photodiodes or photomultipliers.

9. A device for determining the quality of plant material using the method according to any one of the claims 1-8, comprising first means for irradiating the plant material with a beam of electromagnetic radiation comprising one or more such wavelengths that at least a part of the chlorophyll present in the plant material is excitated, first means for scanning the beam of electromagnetic radiation over the plant material with a high scan frequency, first means for measuring the fluorescence radiation originating from the plant material for obtaining a chlorophyll fluorescence image (Ffast) associated with the fast scan, second means for irradiating the plant material with a beam of electromagnetic radiation comprising one or more such wavelengths that at least a part of the chlorophyll present in the plant material is excitated, second means for scanning the beam of electromagnetic radiation over the plant material with a low scan frequency, second means for measuring the fluorescence radiation originating from the plant material for obtaining a chlorophyll fluorescence image (Fslow) associated with the slow scan and means for processing the chlorophyll fluorescence images Ffast and Fslow, wherein said processing means is

provided with calculating means for calculating a characteristic chlorophyll fluorescence image that is a measure for the quantum efficiency of the photosynthetic activity of the photosynthetic system of the plant material.

10. A device according to claim 9, the first and second means for irradiating the plant material consisting of the same laser wherein the laser line is scanned with a high frequency and a low frequency, respectively, over the plant material, the first and second means for measuring the chlorophyll fluorescence images consisting of a camera connected to a computer and the means for processing the fluorescence images consisting of a computer provided with software for processing the chlorophyll fluorescence images of the fast and the slow scan, wherein said software performs the step of calculating a characteristic chlorophyll fluorescence image that is a measure for the quantum efficiency of the photosynthetic activity of the photosynthetic system of the plant material from Ffast and Fslow.

11. A method for separating plant material consisting of individual components into several fractions each having a different quality, wherein a characteristic parameter is determined for each component using the method according to any one of the claims 1-8 or the device according to claim 9 or 10 and the fractions of components having the characteristic parameter in the same pre-determined range are collected.

12. A method according to claim 11, the plant material consisting of plants, cut flowers, leaf material, fruits, berries, vegetables, flowers, flower organs, roots, tissue culture, seeds, bulbs, algae, mosses and tubers of plants.

13. A method according to claim 12, each individual component consisting of separate plants, cut flowers, leaf material, fruits, berries, vegetables, flowers, flower organs, roots, tissue culture, seeds, bulbs, algae, mosses and tubers of plants.

14. A device for separating plant material consisting of individual components into several fractions each having a different quality, comprising a supply part for the plant material, a device according to claim 9 or claim 10 that determines a characteristic parameter for each component, and a separation part that separates the components into fractions of components having the characteristic

parameter in the same pre-determined range.

15. A method for classifying plant material consisting of individual components into several fractions each having a different quality, wherein a characteristic parameter is determined for each component using the method according to any one of the claims 1-8 or the device according to claim 9 or 10 and the fractions of components having the characteristic parameter in the same pre-determined range are collected.

16. A method according to claim 15, the plant material consisting of plants, cut flowers, leaf material, fruits, berries, vegetables, flowers, flower organs, roots, tissue culture, seeds, bulbs, algae, mosses and tubers of plants.

17. A method according to claim 16, each individual component consisting of individual plants, cut flowers, leaf material, fruits, berries, vegetables, flowers, flower organs, roots, tissue culture, seeds, bulbs, algae, mosses and tubers of plants.

18. A device for classifying plant material consisting of individual components into several fractions each having a different quality, comprising a moving structure that localises the plant material, a device according to claim 9 or claim 10 that determines a characteristic parameter for each component, and a classification part that collects fractions of components having the characteristic parameter in the same pre-determined range.